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EVIDENCE FOR AND IMPLICATIONS OF AN EARLY ARCHEAN TERRESTRIAL IMPACT RECORD. Donald R. Lowe, Department of Geology, Stanford University, Stanford, CA 94305, and Gary R. Byerly, Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA 70803.

Early Archean, 3.5 to 3.2 Ga, greenstone sequences in South Africa and Western Australia contain a well-preserved record of early terrestrial meteorite impacts. The main impact-produced deposits are layers, 10 cm to over 1 m thick, composed largely of sand-sized spherules, 0.1 to 4 mm in diameter. The beds studied to date show an assemblage of features indicating formation by the fall of debris from impact-generated ejecta clouds.

(1) Some layers crop out over enormous areas, forming regional marker units for correlation among structurally isolated blocks within the greenstone belts [1,2].

(2) The spherule deposits are not associated with volcanic centers and generally lack juvenile volcanic and volcaniclastic components [1].

(3) The spherules show pseudomorphed internal textures indicating that they formed by the quenching of liquid silicate droplets [1,2].

(4) Prior to Archean metasomatism, the spherules were compositionally diverse, ranging from nearly pure silica to basaltic and possibly ultramafic varieties, commonly mixed within single beds [1,3].

(5) In shallow water settings, the spherule layers commonly show extensive working by short-lived, energetic currents, even where the long-term depositional environment was dominated by extremely low-energy conditions. These short-lived current events coincident with deposition of the spherule layers are thought to represent impact-generated tsunamis [2].

(6) At least two of the layers in South Africa show pronounced iridium anomalies with Ir contents as high as 100 to 160 ppb compared to maximum measured background levels of about 5 ppb on komatiites [4].

(7) Preliminary data on the relative abundances of the noble metals Os, Pt, Pd, Au, and Ir are roughly chondritic with element/Ir ratios for Os, Pt, Pd, and Au within a factor of 2 of chondritic [5].

These data effectively rule out normal magmatic or sedimentary processes in the origin of these units and provide substantial support for an origin by large impacts on the early earth. The presence of at least four, remarkably thick, nearly pure spherule layers suggests that smaller-scale impact deposits may be even more abundant in these sequences. The existence of a well-preserved Archean terrestrial impact record suggests that a direct source of evidence is available regarding a number of important aspects of early earth history: (1) the Archean terrestrial impact rate; (2) the constraints impacts may have placed on the evolution of early life; (3) the influence of impacts on early tectonic, magmatic, and metallogenic processes and the evolution of greenstone belts and continents; and (4) the nature of impact processes and the dynamics and dispersal of large, impact-generated vapor and dust clouds.

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